2.0 RED RIVER WATERSHED BACKGROUND

2.1 Description and Land Ownership

The Red River, which originates in the Sangre de Cristo Range among New Mexico's highest peaks, including the 13,161-foot Wheeler Peak, is an important tributary to the Rio Grande. The river's sources are fed by relatively consistent patterns of orographic precipitation, including snowmelt and summer season convective storms.

The Red River Watershed covers approximately 187 square miles (mi^2) in northern New Mexico. It is dominated by conifer forest, but includes rangeland, agricultural and mining areas, barren lands, and built-up areas (Figure 2.1). Most of the land is managed by the United States Department of Agriculture (USDA) Forest Service (USFS). A much smaller area (4 percent[%]) is under the purview of the Bureau of Land Management (BLM) (Figure 2.2). The watershed consists almost entirely of Federal lands, with approximately 8% privately held land.

2.2 Geology

The watershed has two distinct characters, owing to an abrupt change in geology along its course. Along its upper and middle reaches, in the high mountains of the Carson National Forest, the Red River is a freestone stream flowing across wide meadows and through narrow canyons (Figure 2.3). The gradient along this reach ranges from approximately 70 to 130 feet per mile, decreasing downstream. The terrain is derived from erosion and the river's downcutting into Precambrian igneous and metamorphic basement rocks and Tertiary volcanic intrusives (altered and unaltered). Cabresto Creek joins the Red River in the lower part of this section and is its largest tributary. During the irrigation season, which usually lasts from May through September, essentially the entire flow of Cabresto creek is diverted, disconnecting it from the Red River. A significant portion of the Cabresto Creek watershed is encompassed by the Latir Peak Wilderness area, which includes the northernmost reaches of the Red River Basin (Figure 2.2).

As it nears the Rio Grande Gorge, the Lower Red River has carved a deep canyon through the Quaternary alluvial deposits and Tertiary conglomerates and volcanic flows of the Rio Grande rift system (Figure 2.3). The average gradient along this reach is approximately 150 feet per mile. In this section, the river flows through boulder-choked pockets of water and is similar in character to the Rio Grande itself. The lowermost section of the river is included in the Rio Grande Wild and Scenic River area.

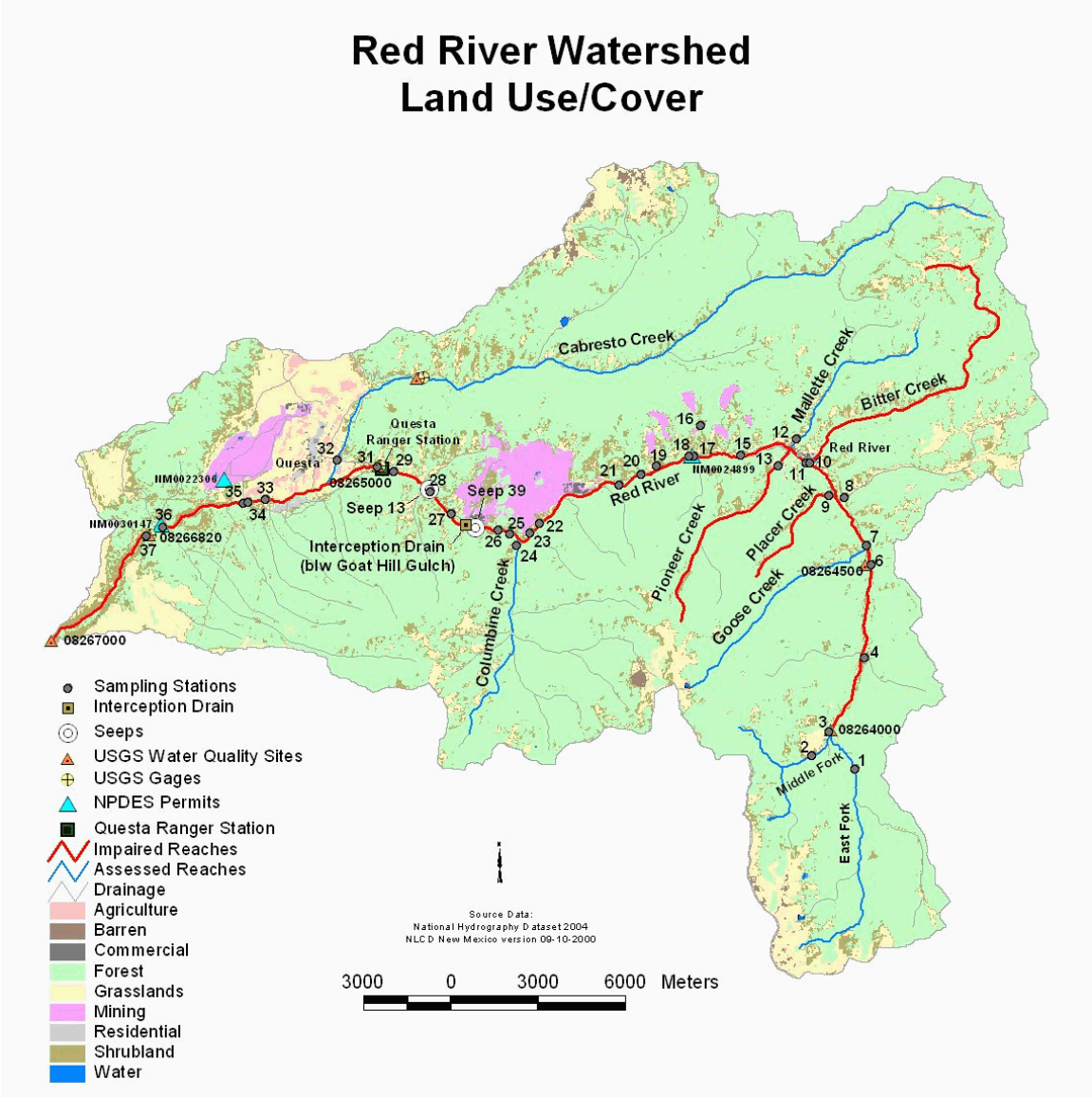

Figure 2.1 Red River Watershed Land Use/Land Cover and Sampling Stations

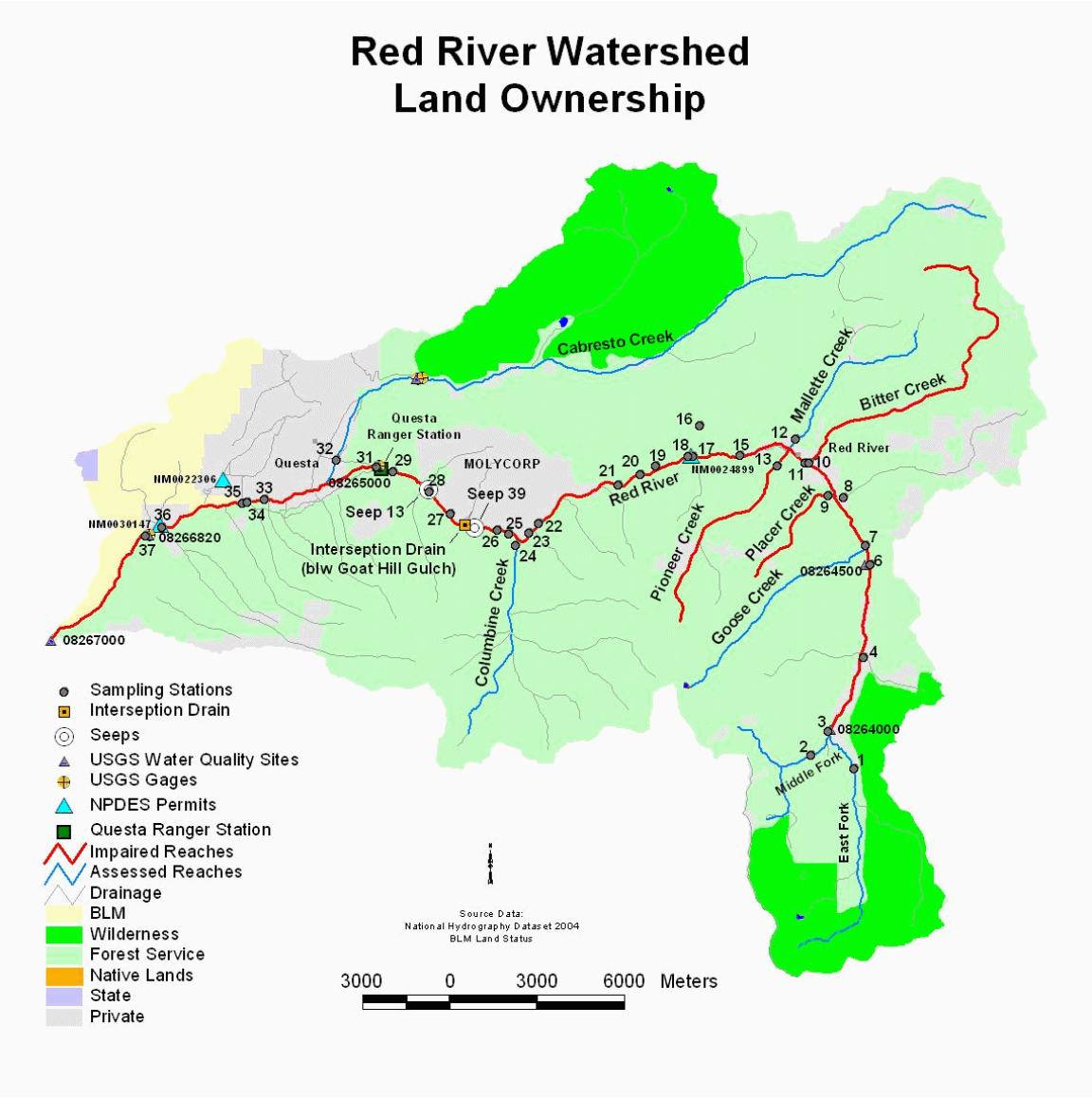

Figure 2.2 Red River Watershed Land Ownership and Sampling Stations

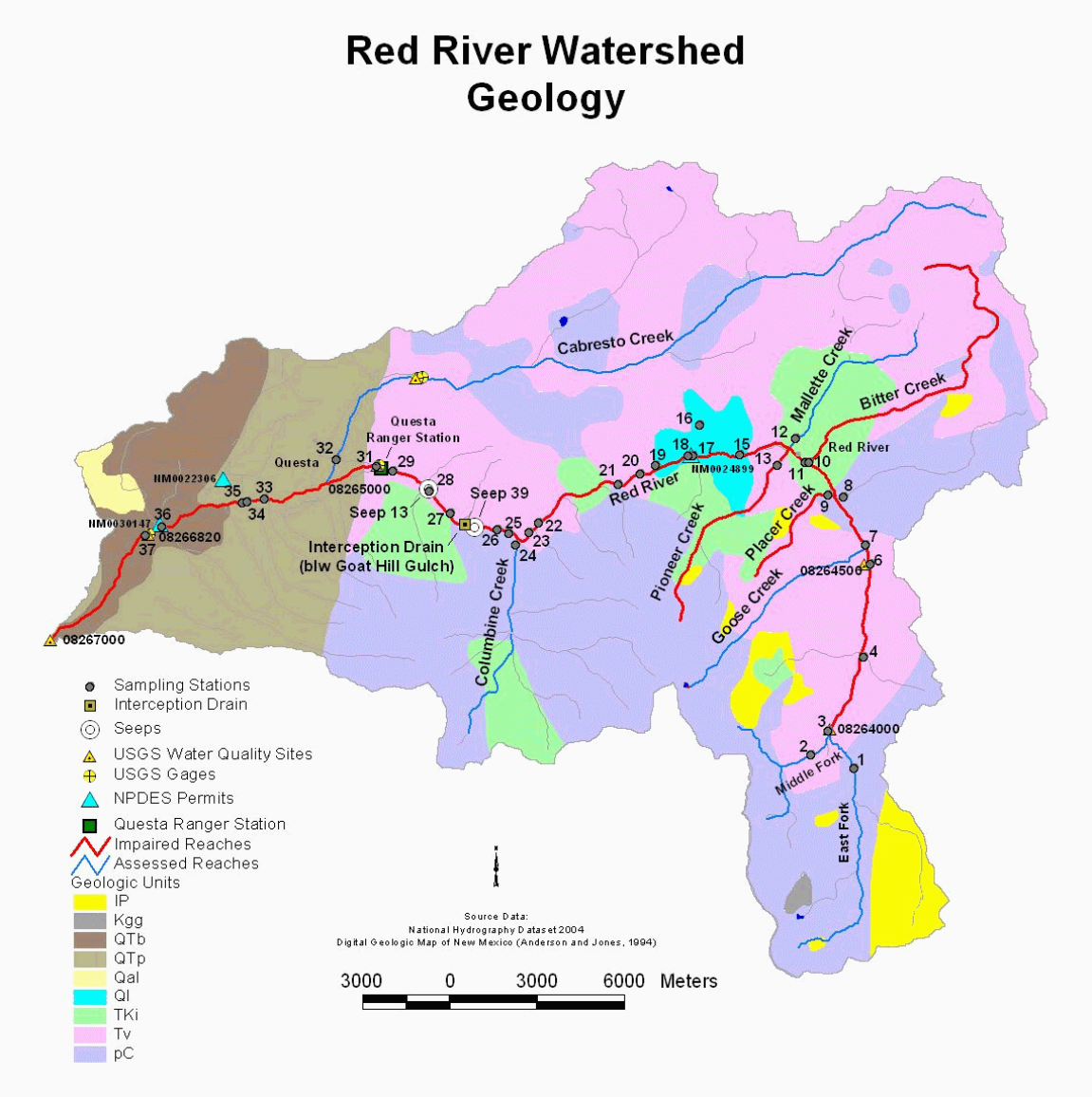

Figure 2.3 Red River Watershed Geology

Table 2.1 Geologic Unit Definitions for the Red River Basin (see Figure 2.3)

Geologic Unit Code	Definition
IP	Pennsylvanian (age) rocks
K_{gg}	Graneros Shale and Greenhorn Formation; limited to northeastern area; lower Turonian and Cenomanian
QT_b	Basaltic and andesitic volcanics interbedded with Pleistocene and Pliocene sedimentary units
QT_p	Older Piedmont alluvial deposit and shallow basin fill
Q_{al}	Alluvium, Q_a
Q_l	Landslide deposits and colluvium
TK_i	Paleogene and Upper Cretaceous intrusive rocks
Tv	Middle Tertiary volcanic rocks, undifferentiated
pC	Precambrian

2.2.1 Alteration Scars

In the Red River drainage basin, there are approximately 25 distinct alteration scar areas that range in size from < 0.1 square kilometers (km^2) (<24.7 acres) to approximately 0.5 km^2 (123.6 acres). These areas collectively encompass approximately 600 acres, which amounts to 0.5% of the basin's area. Alteration scars are landforms characterized by steep slopes, a lack of soil, iron oxide staining and clay formation, rapid erosion, and common slumping and landsliding (Meyer and Leonardson 1990). Runoff from the highly visible scars in the Red River valley contains elevated concentrations of iron oxides and clay minerals that turn the water orange, giving the Red River its name. The scars are thought to develop as a result of landslides and erosion in areas that become susceptible to mass wasting. Areas of faulting, fracturing, supergene alteration (weathering), and hydrothermal alteration are prone to landslides and scar development due to diminished shear strength of the affected rock mass (Meyer and Leonardson 1990). In addition, anthropogenic activity, such as mining, roads, etc, in the Red River area aggravates scar development and the associated effects on water quality (RGI 2000).

The scars are found mostly on the north side of the river and are aligned along two parallel, east to west trends (Meyer and Leonardson 1990) that follow the trend of mineralization (Figure 2.4). The south-facing slopes have a lower density of stabilizing forest cover and other vegetation than the north-facing slopes (Meyer and Leonardson 1990). The majority of the erosional scars are located east of the Molycorp Mine, but natural scars are also located within the mine's property.

Photo 2.1 Alteration Scar in the Straight Creek Watershed

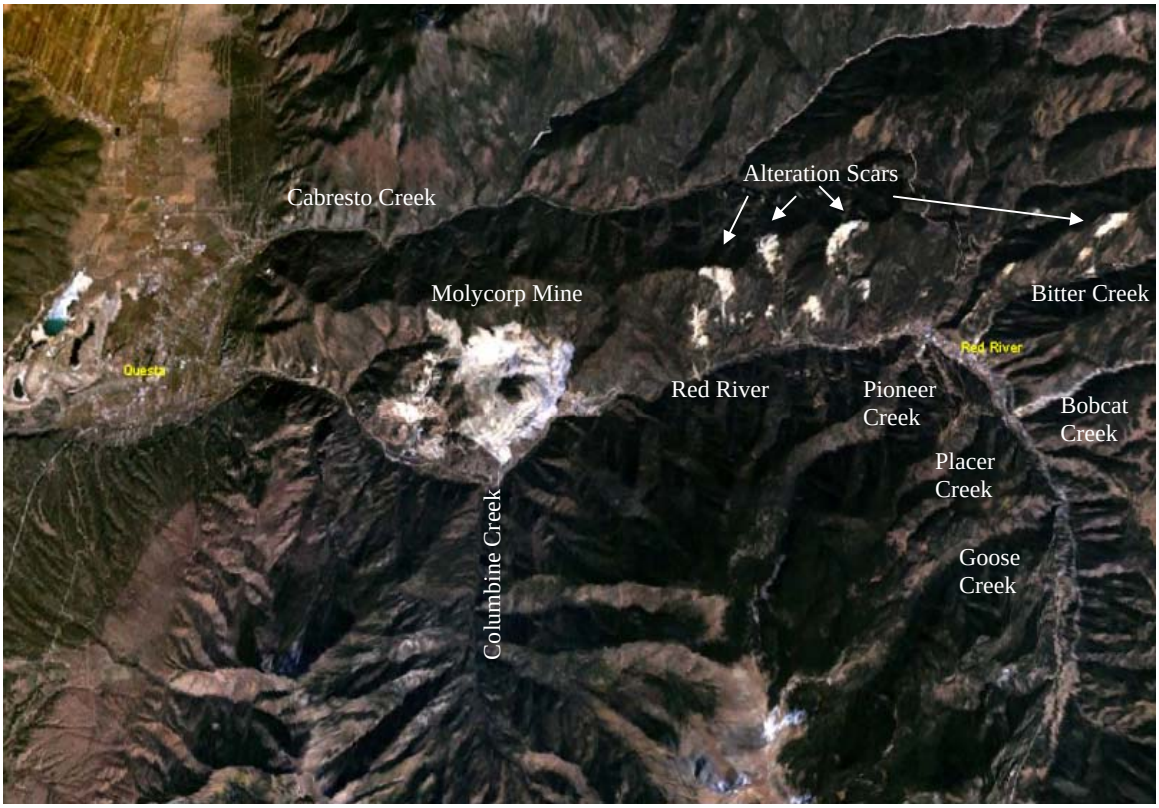

Figure 2.4 Satellite Image of the Red River Watershed, showing the Molycorp Mine Site and Alteration Scars along the North Side of the Red River

A high pyrite content of 3 to 5% is common in scar areas, while a lower pyrite content of 1% or less is typical throughout most of the region in nonmineralized zones and 1 to 3% in mineralized zones. Samples taken from scar areas have yielded acidic-paste pH measurements as low as 0.8 (RGI 2000) due to pyrite oxidation and acidic water generation, but typically range between 2-4 s.u. This indicates that weathering scars can also contribute to acid rock drainage, dissolved constituent loads in ephemeral overland flow that follows the steep drainage systems, and acidic groundwater recharge that eventually seeps or flows into the river (NMED 1996). Because the scars are also highly erosive and are the source of sediment; debris flows often wash across State Highway 38 and into the Red River during periods of heavy precipitation or snowmelt.

2.2.2 Molybdenum Mining

A molybdenum mine owned by Molycorp, Inc. is located north of the Red River between the Village of Questa and the Town of Red River (Figure 2.4). The mine occupies an almost three-square-mile area that is surrounded by the Carson National Forest (NMED 1996). Mining operations at the property have been carried out in three phases (historic underground, open pit, and block-caving methods) since 1919 (URS 2001). Over 100 million tons of tailing material that was generated in the open pit mining process were transported in slurry form by a 8-mile pipeline, and deposited in two unlined tailings ponds that are located west of Questa (Figure 2.1). Numerous spills have originated from the pipeline. Some of these spills have entered the Red River at various times since the construction of the pipelines. Currently, pursuant to Discharge Permit 933, Molycorp is investigating historic spills and the impact that those spills have to the environment. Also, during pit development, a series of waste rock piles (approximately 320 million tons) were placed in Capulin Canyon, Goathill Gulch, Sulpher Gulch, Spring Gulch, Blind Gulch, and many unnamed drainages located within the Molycorp property boundary along Highway 38, which parallels the Red River. The waste rock piles consist of mineralized rocks that contain pyrite, and non-mineralized rocks. The reaction between air and water with pyrite produces an acidic solution that leach metals such as aluminum. Presently, the acidic leachate reaches the Red River either through seeps and springs, or the interaction between groundwater and the Red River.

The mine is currently developing and refining plans for operational and closure conditions to protect surface and ground water quality pursuant to Discharge Permit (DP)-1055, DP-933 and the National Pollutant Discharge Elimination System (NPDES) permit. One of the conditions in DP-1055 is to determine pre-mining background ground water concentrations at the Molycorp mine site. A study of background conditions was conducted in 2001 and 2002 by the United States Geological Survey (USGS) in conjunction with the New Mexico Environment Department (NMED), Molycorp and a local environmental group. Pertinent results from the USGS study are incorporated into this TMDL document.

2.3 Water Quality Standards

Water quality standards (WQS) for all assessment units in this document are set forth in the following various sections of *New Mexico Standards for Interstate and Intrastate Surface Waters* (NM Administrative Code [NMAC] 20.6.4) (NMAC 2002):

20.6.4.122 RIO GRANDE BASIN - The main stem of the Rio Grande from Taos Junction bridge upstream to the New Mexico-Colorado line, the Red river from its mouth on the Rio Grande upstream to the mouth of Placer creek, and the Rio Pueblo de Taos from its mouth on the Rio Grande upstream to the mouth of the Rio Grande del Rancho.

A. Designated Uses: coldwater fishery, fish culture, irrigation, livestock watering, wildlife habitat, and primary contact.

B. Standards:

(1) In any single sample: pH shall be within the range of 6.6 to 8.8, temperature shall not exceed 20°C (68°F), and turbidity shall not exceed 50 NTU. The use-specific numeric standards set forth in 20.6.4.900 NMAC are applicable to the designated uses listed above in Subsection A of this section.

(2) The monthly geometric mean of fecal coliform bacteria shall not exceed 100/100 mL; no single sample shall exceed 200/100 mL (see Subsection B of 20.6.4.13 NMAC).

20.6.4.123 RIO GRANDE BASIN - The Red river upstream of the mouth of Placer creek, all tributaries to the Red river, and all other perennial reaches of tributaries to the Rio Grande in Taos and Rio Arriba counties unless included in other segments.

A. Designated Uses: domestic water supply, fish culture, high quality coldwater fishery, irrigation, livestock watering, wildlife habitat, and secondary contact.

B. Standards:

(1) In any single sample: conductivity shall not exceed 400 µmhos (500 µmhos for the Rio Fernando de Taos), pH shall be within the range of 6.6 to 8.8, temperature shall not exceed 20°C (68°F), and turbidity shall not exceed 25 NTU. The use-specific numeric standards set forth in 20.6.4.900 NMAC are applicable to the designated uses listed above in Subsection A of this section.

(2) The monthly geometric mean of fecal coliform bacteria shall not exceed 100/100 mL; no single sample shall exceed 200/100 mL (see Subsection B of 20.6.4.13 NMAC).

NMAC 20.6.4.900 provides standards applicable to attainable or designated uses unless otherwise specified in 20.6.4.101 through 20.6.4.899. This section includes the dissolved aluminum chronic and acute criterion of 0.087 and 0.75 milligrams per liter (mg/L), respectively, for Aquatic Life Habitat uses discussed in Section 6.0 of this document. NMAC 20.6.4.12 lists general standards that apply to all surface waters of the state at all times, unless a specified standard is provided elsewhere in NMAC.

NMED proposed several modifications to the New Mexico WQS during the February 2004 triennial review hearings. Changes that will potentially affect the Red River watershed are:

- Changing the criteria related to contact uses from fecal coliform to *E. coli* (monthly

geometric mean of 126 colony forming units (cfu)/100 mL or less and single sample 235 cfu/100 mL).

- The addition of a total phosphorus criteria of 0.1 mg/L in NMAC 20.6.4.123.
- The segment-specific turbidity criteria has been replaced with the following language applicable to all surface waters:

> **Turbidity**: Turbidity attributable to other than natural causes shall not reduce light transmission to the point that the normal growth, function or reproduction of aquatic life is impaired or that will cause substantial visible contrast with the natural appearance of the water. Turbidity shall not exceed 10 NTU over background turbidity when the background turbidity is 50 NTU or less, or increase more than 20 percent when the background turbidity is more than 50 NTU. Background turbidity shall be measured at a point immediately upstream of the turbidity-causing activity. However, limited-duration activities necessary to accommodate dredging, construction or other similar activities and that cause the criterion to be exceeded may be authorized provided all practicable turbidity control techniques have been applied and all appropriate permits and approvals have been obtained.

Proposed changes to the standards have been approved by the New Mexico Water Quality Control Commission (WQCC), but are still under review and have not been approved by USEPA at the time of this writing. Accordingly, this TMDL document was prepared using the existing WQS (NMAC 2002). The approval of the proposed WQS changes for the Red River watershed by USEPA will not affect the TMDLs included in this document.

2.4 Intensive Water Quality Sampling

The Red River watershed was intensively sampled by the SWQB in 1999, with additional geomorphic and biological data collected in the Fall of 2001. A brief summary of the survey and the hydrologic conditions during the intensive sample period is provided in the following subsections. A more detailed description of the Red River intensive survey can be found in the *Water Quality Survey Summary for the Red River and Tributaries* available online at http://www.nmenv.state.nm.us/swqb/Surveys/RedRiver1999.pdf (NMED/SWQB 2004b).

2.4.1 Survey Design

Surface water quality samples were collected on a seasonal basis between May and October for the 1999 intensive SWQB study. Surface water quality monitoring stations were selected to characterize water quality of various assessment units (i.e., stream reaches) throughout the watershed (Table 2.2, Figures 2.1 through 2.3). Stations were located to evaluate the impact of tributary streams and to determine ambient and background water quality conditions. Surface water grab samples stations were analyzed for a variety of chemical/physical parameters. Data results from grab sampling are housed in the SWQB provisional water quality database and were uploaded to USEPA's Storage and Retrieval (STORET) database.

Table 2.2 SWQB 1999 Red River Sampling Stations

Station	Location Description
1	East Fork Red River at Ditch cabin
2	Middle Fork Red River
3	Red River below confluence of East and Middle forks
4	Black Copper Canyon
5	Bear Creek – visual assessment only
6	Red River at Zwergle Dam
6a	Red River at upper recreation crossing (QA duplicate)
7	Red River below Goose Creek
8	Bobcat Creek
9	Placer Creek
10	Bitter Creek
11	Red River below Bitter Creek
12	Mallette Creek
13	Pioneer Creek
14	Haut-N-Taut Creek (ephemeral)
15	Red River at Junebug Campground
16	Straight Creek (ephemeral)
17	Red River above Red River WWTP
18	Red River below Red River WWTP
19	Hansen Creek (ephemeral)
20	Red River below Hansen Creek
21	Red River at upper Molycorp boundary
22	Red River above Molycorp mine seep #2
23	Red River at Columbine Creek
24	Columbine Creek
25	Red River above Molycorp mine seep #3
26	Red River between seeps #3 and #4
27	Red River at Goat Hill Gulch campground
28	Red River above Capulin Creek
29	Red River below Capulin Creek
29a	Red River at picnic area (QA duplicate)
30	Not used – merged with 29
31	Red River at Questa USGS gage
32	Cabresto Creek at Hwy 38
33	Red River at Hwy 522 bridge
34	Red River below Questa WWTP
35	Red River below Molycorp outfall 002
36	Red River above hatchery (biology and geomorphology)
37	Red River below hatchery
37a	Red River above canyon mouth (QA duplicate)

All sampling and assessment techniques used during the 1999 intensive SWQB survey are detailed in the *Quality Assurance Project Plan* (QAPP) (NMED/SWQB 1999a) and assessment protocols (NMED/SWQB 2004c). As a result of the 1999 SWQB monitoring efforts and subsequent sampling by Molycorp, Inc, several surface water impairments were determined. Accordingly, these impairments remained on New Mexico's 2004-2006 Integrated CWA §303 (d)/305(b) list (NMED/SWQB 2004a).

Additional water quality data has been collect by Molycorp, Inc. as part of the Remedial Investigation/Feasibility Study (RI/FS) process currently being conducted at Molycorp's Questa Mine and as part of DP-1055 and DP-933. This additional data was used in the assessment process to determine impairments within the Red River. This data was not included in the determination of measured load (Section 6.0) of this document because it was not collected during the critical period for the aluminum TMDL.

In April 2001, the USGS and NMED began a cooperative study at the Molycorp Questa mine site to determine pre-mining or natural background water chemistry concentrations for the Questa site. USGS has published the results of several of these extensive studies on their USGS website at http://wwwbrr.cr.usgs.gov/projects/GWC_chemtherm/questa.htm. The results of these studies were used in this TMDL to assist in the determination of the aluminum loads in the Red River.

2.4.2 Hydrologic Conditions

There are two active, real-time USGS gaging stations in the Red River watershed associated with the reaches presented in this document. USGS gage locations are presented in Figures 2.1 through 2.3. Daily stream flow for these USGS gages are presented graphically in Figures 2.5 and 2.6 for the 1999-2002 calendar years.

The Red River is fed by numerous springs and shallow alluvial ground water discharges rendering it a gaining stream over a large portion of its length (Smolka and Tague, 1989). Numerous ephemeral/intermittent seeps and springs were identified along the Red River between the town of Red River and the gaging station near Questa during the USGS low-flow and snowmelt tracer studies (McCleskey *et al* 2003).

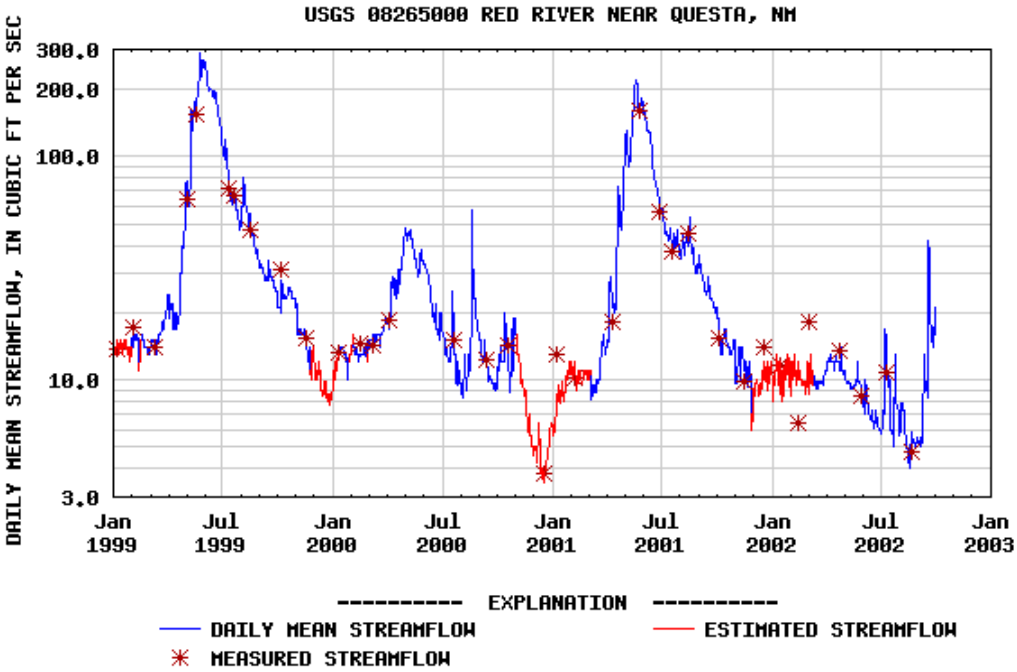

Figure 2.5 January 1999 - December 2002 USGS Average Daily Streamflow, Red River near Questa, NM

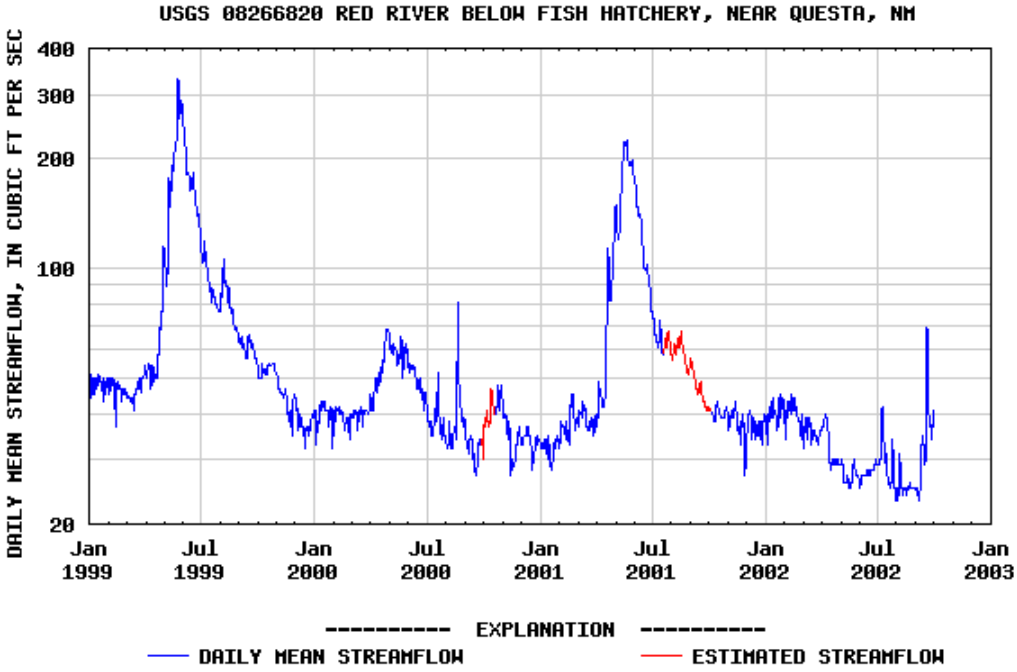

Figure 2.6 January 1999 – December 2002 USGS Average Daily Streamflow, Red River below Fish Hatchery near Questa, NM

The 1999 SWQB intensive survey was performed over varying flow conditions from May to October. During the spring of 1999, the Red River snow melt occurred earlier than usual, peaking at least twice before the sampling effort began. The studies performed by the USGS were carried out during low-flow conditions in August 2001 and snowmelt conditions in March 2002. Flows during 2001 and 2002 were below average based on the period of record, but the flows recorded in 1999 were slightly above average with a very good snow pack. In terms of assessing designated use attainment in ambient surface waters, WQS apply at all times under all flow conditions.